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Assessment of Pulmonary Function Test among Petrol Pump Workers in Bankura District

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Abstract

Background and Aim: Health problems posed by the pollutants at the working environment of an individual are linked to the nature and level of exposure to these hazardous chemicals. Petrol pump workers are exposed to high level of different types of air pollution along with petrol and diesel vapors exhibit a number of effects on the respiratory functions. The main objective of the study was to assess the pulmonary functions in petrol pump workers (filling attendants) who are continuously exposed to petrol/diesel vapors during duty hours and compare with the normal healthy individuals. **Materials and Methods:** This is a cross-sectional study was conducted at seven different petrol pumps of Bankura and 65 petrol pump workers (filling attendants) were included. Each subject's age, smoking habits, the duration of exposure, health conditions, BMI and BP were recorded. Their PFT were assessed using spirometer and was compared with 65 normal healthy individuals. **Results:** A significant decrease in the values of Tidal Volume, Vital Capacity, Peak Expiratory Flow Rate, Maximum Voluntary Ventilation, Respiratory Rate and Oxygen saturation in petrol pump workers when compared to control group. Significant increase in BP was observed in case of petrol pump workers and reduction in muscle strength. **Conclusion:** The present findings demonstrate the adverse effects of petrol and diesel vapors and fumes, hydrocarbons markedly decreased the pulmonary functions.

Keywords: Petrol pumps workers, Petrol/diesel vapors, Pulmonary function tests, Spirometry, Vital capacity

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Introduction

Air pollution caused from vehicles is an inescapable part of the modern urban life. Globalization, rapid industrial growth, and poor environmental conditions at workplaces have created a lot of health-related issues. There is a high prevalence of occupational health disorders such as silicosis, asbestosis, and pneumoconiosis among workers working in different industrial environments in India.[1] Fast urbanization process trends, resulted in a tremendous rise in the number of transportation vehicles, thereby, resulting in the increased demand of petrol. This increase in demand of petrol has led to a steady rise in the number of petrol pumps in the country.

India is a rapidly developing country and automobiles plying on roads are increasing each day. This has led to an increase in petrol pump stations and petrol pump workers and also exposure of petrol pump workers to vapors of petrol and gases from exhaust of automobiles.[2] The rising number of vehicles has sharply increased the level of air pollution in various cities of India. Petrol vapors and gases from automobile exhaust have a deleterious effect on the respiratory system.

A Health Survey done by the Centre for Science and Environment, New Delhi, has shown that 141 (80%) cities in India exceed the PM 10 (pollutants that emit particulate matter of <10 micrometers in size) standard, 90 cities have a critical level of PM 10 and 26 cities have the most critical level, exceeding thrice the standards.[3]

Exposure of petrol pump workers to petroleum fumes and gases from exhaust of automobiles is also increased.[4] A long-term exposure to petrol and diesel fumes leads to a deleterious effect on respiratory function. Studies on pulmonary function tests of petrol pump workers reveal restrictive pattern[5,6] and mixed pattern[7,8] of lung disease which also depends on the duration of exposure mostly significant decline when exposure >5 years.

Petrol is a complex combination of hydrocarbons which contain 95% aliphatic and acyclic compounds and <2% are aromatics.[9,10] These petroleum products (petrol, diesel) contain various organic compounds such as benzene, toluene, ethylbenzene, and xylene (BTEX compound).[11] Benzene is one of the active compounds in petrol and it is responsible for the physiological dysfunction in respiratory, hematological, and thyroid function in petrol pump workers. Petrol pump workers are coming in contact with these BTEX compounds through inhalation, ingestion, and dermal contacts. However, the main route of exposure is the respiratory system. Long-time exposure of this petroleum vapor causes bronchoconstriction.[12,13]

Petrol and diesel exhaust, in addition to generating pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world.[14] These two petro products have become an essential commodity for today's speedy life. To mitigate this need there is alarming increase in fuel consumption, increased inhalation of occupational solvents into the human body, and a resultant hike in the incidence of health hazards that have been increasingly observed in the recent days.[15]

Both petrol and diesel undergo combustion in automobile engines and give rise to combustion-derived nanoparticles. These particles are highly respirable and have a large surface area which can carry a larger fraction of toxic hydrocarbons and metals on

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their surface. They can remain airborne for longer time periods and can be deposited in greater numbers and deeper into the lungs than the large-sized particles.[16] Petrol evaporates more readily in hot than cold countries. In India, petrol-pump attendants are the norm rather than self-service, increasing the opportunity for exposure. Petrol-pump attendants do not wear personal protective equipment and personal hygiene is variable in the workplace.

Petrol pump workers (filling attendants) are continuously exposed to the organic and inorganic substances present in the petrol. Their average daily exposure exceeds about 10 h/day. Some of them are working for more than ten years now. Hence Petrol pump workers (filling attendants) are continuously exposed to the organic and inorganic substances present in the petrol.[17,18] Petrol-pump workers who are exposed to the petrol fumes exhibit a number of clinical signs and symptoms which may be due to benzene toxicity. Symptoms like chronic cough, wheezing and breathlessness have been reported on exposure to these pollutants.[19,20] At high concentrations, well defined and marked systemic pulmonary inflammatory response is also observed in healthy human volunteers.[21] Duration of exposure may vary depending on their occupation tenure. Hence, this study was planned to assess lung function according to the duration of occupational exposure in petrol pump workers.

The failure to use personal protective equipment poses a great risk for the petrol-filling workers. In India, petrol filling workers are employed rather than self-serviced, increasing the opportunity for exposure. To meet the present day requirement, there are many petrol-filling stations getting established and there is an increased recruitment of workers. Health effects of occupational exposure to gasoline and air pollution from vehicular sources are relatively unexplored among petrol-filling workers.[6]

Potential Harm from Lung Function Tests

The most likely harm from lung function testing originates probably from four key factors:

1. Maximal pressures generated in the thorax and their impact on abdominal and thoracic organs/tissues.
2. Large swings in blood pressure cause stresses on tissues in the body (head, limbs, etc.).
3. Expansion of the chest wall and lungs.
4. Active communicable diseases (tuberculosis, hepatitis B, HIV, etc.).

The present study mainly focuses on pulmonary functions in petrol-pump workers (filling attendants) in urban area of Bankura, who are continuously exposed to petrol/diesel vapors during duty hours and also assess the extent of altered cardiovascular functions in petrol-pump workers. In-addition, the effect of the duration of the service at the petrol-pumps was also studied and these changes were compared with those of age-matched healthy controls.

Materials and Methods

The present study was a cross-sectional study, conducted in the rural area of Bankura petrol pumps. 7-petrol pumps were selected for this study.

Questionnaire includes demographic information (gender and age), food habits, medical history (hypertension, diabetes, coronary heart disease, chronic renal disease, chronic respiratory diseases, etc.) behavior and personal habits (e.g., smoking) and family history was taken. Lung function test was done during visit to the petrol pump. An informed written consent was taken after explaining the procedure to the subjects.

Exclusion Criteria

- Smokers
- Chronic respiratory disease
- Cardiac disease
- Examination finding suggestive of respiratory or cardiac disease
- Body Mass Index more than 30

Sample Size

Statistically adequate number of samples of 65 male petrol-pump workers (filling attendants) (Group-II) and 65 control subjects (Group-1) with the age group of 20–50 years were selected in the present study. The subject comprises male with their age-matched between normal and petrol pump workers. Informed consent was obtained from all the subjects. Subjects with age above 50-years and <20 years and any chronic illness, on any medication and smokers were excluded from this study.

Anthropological Parameters

Each subject following parameters was measured such as height, weight, and circumferences at waist and hip. Anthropometric measurements were taken using standard protocols given by Weiner and Lourie.[22,23]

Measurement of Pulse Rate and Blood Pressure

Measurement of pulse rate

Pulse rate is measured in the right radial artery after all participants had rested for at least 10 min before and after exercise. Pulse rate was measured using three fingers and for a complete minute in supine, in sitting and standing positions. The results were recorded as pulse rate per minute and then analyzed.

Measurement of blood pressure

Blood pressure was measured by the auscultatory method in the right arm in supine, sitting, and standing position using a mercury sphygmomanometer with a cuff of 12 cm. widths. All the subjects were made to rest for at least 10 min before taking the readings. The manometer cuff was sungly tied around the arm with tubing on the medial and the lower side. Systolic blood pressure was recorded to the nearest 2 mm of Hg at the appearance of the first Korotkoff sound, and diastolic blood pressure was recorded to the nearest 2 mm of Hg at the disappearance of Korotkoff sound. Systolic and diastolic blood pressure was recorded first in the supine position and then standing position, with cuff tied to the arm. Reading was taken in all 3-positions and was analysed.[24]

Assessment for Handgrip Strength

The most common method of assessment for grip strength is the use of a handheld dynamometer. Handheld grip strength dynamometry is used to measure the muscular force generated by flexor mechanism of the hand and forearm. Grip strength has long

been thought of as a possible predictor of overall body strength and also Grip strength may also play a role in injury prevention and rehabilitation.

The participant was in a standing position, arms at their side, not touching their body. Keeping the elbow bent slightly. Administer the test on the non-dominant hand. Now by asking the participant to squeeze the dynamometer with as much force as possible, being careful to squeeze only once for each measurement. Three trials were made with a pause of about 10–20 s between each trial to avoid the effects of muscle fatigue.

Pulmonary Function Tests

The pulmonary function tests were carried out using spirometer.

Determination of Peak Expiratory Flow Rate (PEFR)

Peak expiratory flow is typically measured in units of liters per minute (L/min). Green zone- 80–100% of the usual or normal peak flow reading is clear. Yellow zone- 50–79% of the usual or normal peak flow reading. Red zone- Less than 50% of the usual or normal peak flow reading.

Determination of Oxygen (O_2) Saturation

O_2 saturation is the fraction of O_2-saturated hemoglobin relative to total hemoglobin in the blood. The human body requires and regulates a very precise and specific balance of O_2 in the blood. Normal blood O_2 levels in humans are considered 95–100%. If the level is below 90%, it is considered low resulting in hypoxemia.

Measurement of Respiratory Rate (RR)

The RR is measured when a person is at rest and involves counting the number of breaths for 1 min by counting movements of the chest.

Statistical Analysis

To compute mean difference between the petrol-pump workers (filling attendants) and normal subject in relation to selected physical fitness components mean, standard deviation, and independent "*t*-test" was used. The data were analyzed statistically by using appropriate statistical tools such as mean, standard deviation, and percentage. Coefficient of correlation and was also performed and the level of significance was also tested.

Results

The study group consisted of 65-male petrol pump workers (filling attendants). The mean age of 32.27 ± 14.68 years for control study sample and for petrol pump workers (filling attendants) it is 40.23 ± 12.88. It also summarizes the anthropometric variables and general information in terms of age, height and weight and body mass index, waist and hip size and also history of asthma [Figure 1]. Table 1 shows that petrol pumps workers having slightly less body mass index (BMI) compared to the control subject as per WHO guidelines. Few petrol pump workers also has asthmatic activity.

We also studied the number and duration of petrol pump workers (filling attendants) working in petrol pump during our survey time. The study group consisted of 65-male petrol pump workers (filling attendants). Table 2 shows that the number and duration of petrol filling attendants working in petrol pump [Figure 2]. Out of which maximum number of petrol pump workers (filling attendants) are exposed to the volatile organic compounds such as Benzene, pollutants like Lead, CO, CO_2, Nitrogen oxides, Sulfur oxides, Hydrocarbons and unburned carbon particles for more than 5–10 years or more than 10 years for at-least 10 h/day. Very few amount people are exposed for <1 year to organic and inorganic compounds, hence, Petrol-pump workers who are exposed to the petrol fumes exhibit a number of clinical signs and symptoms which may be due to benzene toxicity.

This study group consisted of 65 male petrol pump workers (filling attendants). Table 3 summarizes the cardiorespiratory parameters in control study sample and petrol pump workers (filling attendants) in terms of heart rate, blood pressure, RR, tidal volume (TV), vital capacity, PEFR, Maximum Voluntary Ventilation (MVV) and percentage of O_2 saturation [Figures 3 and 4].

Table 4 shows the handgrip strength among controls sample and petrol filling attendants. Petrol filling attendants show muscle strength less than control group.

Discussion

This study concludes that the petrol pump workers are at greater risk to develop pulmonary impairment (predominantly restrictive

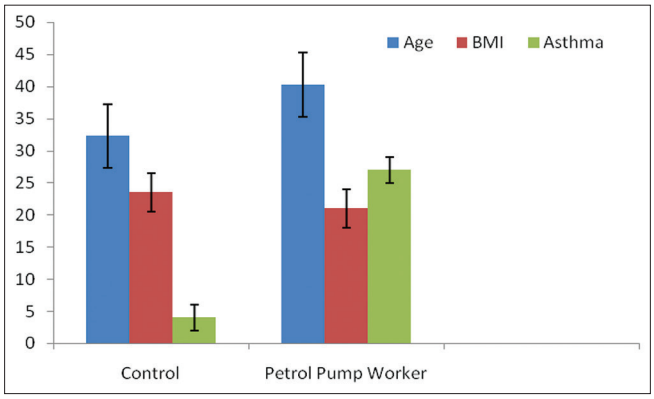

Figure 1: Comparative study of age, BMI and asthma among control and petrol pump worker

Table 1: Anthropometric parameters among control and petrol-pump workers (filling attendants)

Parameters	*Control*	*Petrol-pump workers (filling attendants)*
Age (yrs)	32.27±14.68	40.23±12.88
Height (cm)	162.07±7.45	164.7±10.3
Weight (kg)	65.07±8.79	64.23±914.8
BMI (kg/m^2)	23.52±3.98	23.03±4.5
History of asthma (Y)	2 (6%)	(27.7%)

Table 2: Number and duration of petrol filling attendants working in petrol pump

Parameters	*Number of Petrol-pump workers (filling attendants)*
Exposed For 0–1 year	9 (13.84%)
Exposed For 1–5 year	23 (35.38%)
Exposed For 5–10	13 (20%)
Exposed For more than 10 year	20 (30.76%)

Table 3: Cardio-respiratory parameters in petrol pump workers according to the duration of exposure.

Parameters	*Control*	*Petrol-pump workers (filling attendants)*
Heart Rate (beats/min)	75.34±7.82	87.38±13.89
Systolic Blood Pressure (mm of Hg)	118.05±6.92	149.07±20.44
Diastolic Blood Pressure (mm of Hg)	78.15±4.86	89.23±12.78
Respiratory Rate (times/min)	18.20±4.85	28.84±4.82
Tidal Volume (ml)	420.36±42.81	375.04±58.40
Vital Capacity (L)	2.8±1.39	2.2±0.95
Peak Expiratory Flow Rate (L)	315.86±52.27	299.21±90.62
Maximum Voluntary Ventilation (L)	95.20±10.64	90.35±12.77
% of O_2 saturation	98.05±2.58	96.96±2.36

*Statistically significant (P<0.05)

Table 4: Comparison of muscle strength among rural and urban school students

Parameters	*Control*	*Petrol-pump workers (filling attendants)*
Muscle strength by Handgrip test		
Grip Strength Left (kg)	58.64±5.374	32.23±7.39
Grip Strength Right (kg)	72.3±6.181	34.38±7.88

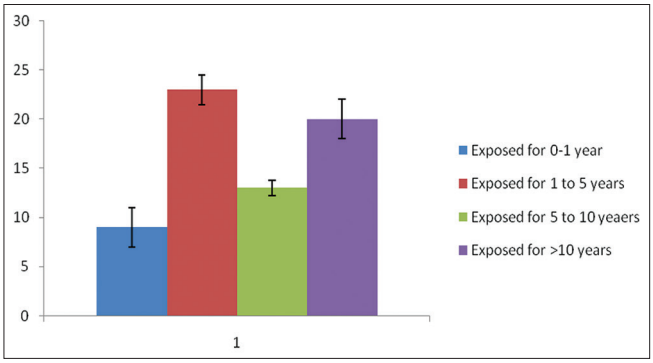

Figure 2: Graphical representation of number and duration of petrol pump attendant working in petrol filling station

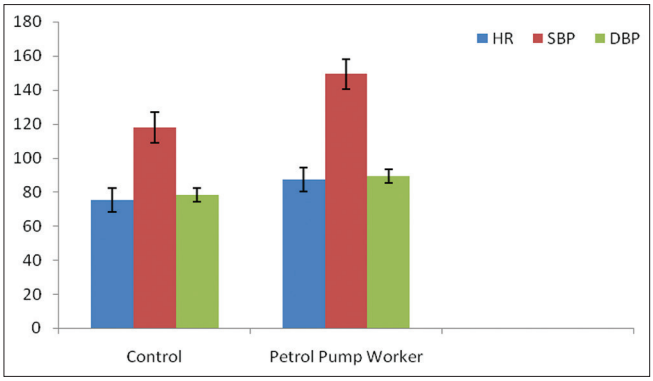

Figure 3: Graphical representation of cardiovascular parameter among control group and petrol filling attendants

pattern of lung disease) with time and also, sensitizes for the need of medical surveillance and implementation of occupational safety

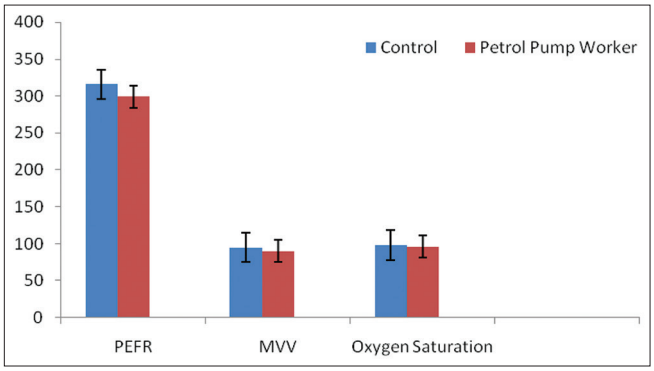

Figure 4: Graphical representation of respiratory parameter among control group and petrol filling attendants

programs to prevent work-related morbidities. The decreased lung functions in petrol-pump workers may be attributed to their exposure to the volatile organic compounds such as Benzene, pollutants such as Lead, CO, CO_2, Nitrogen oxides, Sulphur oxides, Hydrocarbons, and unburned carbon particles for more than 6 months, for at-least 10 h/day.

The parameters such as BMI of above case and control groups were almost similar. More number of petrol pump workers is exposed for 1–5 year and more than 10 year. There was a significant difference in heart rate of petrol pump workers as compared to the control study; heart rate is being significantly increased. BP also increased in case of petrol pump workers compared to the control group.

Our results showed that there was statistically significant decrease in TV, PEFR, MVV, percentage of O_2 saturation values in studied group as compared to control group. In the present study we found that all the lung volumes were decreased in petrol pump workers when compared to control group. A significant decrease was observed in case of working for more than 5 years when compared to those who have worked for <5 years.

Our findings suggest that exposure to petrol vapors fumes, diesel exhaust, and airborne particulate matter leads to impairment in lung functions. This impairment increases with increased duration of exposure. Similar findings were reported by Neena Sharma *et al.*, Singhal *et al.*, Automobile exhaust, petrol, and diesel fuel vapors contain several harmful substances such as oxides of nitrogen, SO_2, CO, CO_2, hydrocarbons, unburned carbon particles (soot), benzene. 50% of ambient particulate matter with diameter < 10 Micro Meters (PM10) is contributed by exhaust of diesel engines.[25] These small particles are easily inhaled and deposit in the lungs.

Conclusion

We found lung function abnormalities in petrol pump workers. Petrol pump workers are continuously exposed to fuel vapors and automobile exhaust. The average duration of daily exposure is about 8 h/day. These pollutants affect even other organs in the body. In order to prevent lung damage in petrol pump workers awareness programs should be conducted and also pre-employment check-up and periodic medical checkups which include pulmonary function tests should be conducted to detect any lung function impairment at the earliest.

The use of protective masks can also reduce exposure to pollutants. Control strategies to reduce benzene concentration in

air emission, improvement in engine design, soot filters and fuel modification such as the use of biodiesel can also go a long way in reducing exposure hazards.

Study group who have lung function impairment during the study were advised to practice some common types of respiratory yoga exercises related to lung functions such as pranayama, sukhasana; so that the respiratory impairment can be overcome.

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Author Contributions

Rajkumar Maiti: Data curation, Writing - Original draft preparation, Conceptualization, Methodology. Prithviraj Karak: Formal analysis and Investigation and Supervision, Review and Editing, and visualization and Software and Validation.

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